

**An Analysis of Benefits, Costs, and Risks
Associated With the Choice of
High-Speed Rail Alignment
Between Los Angeles and Bakersfield**

Draft Report

Prepared for the

City of Palmdale, California

Prepared by

HLB Decision Economics, Inc.

**2233 Watt Avenue, Suite 300
Sacramento, CA 95825**

March 24, 2000August 27, 2004

An Analysis of Benefits, Costs, and Risks Associated With the Choice of High-Speed Rail Alignment Between Los Angeles and Bakersfield

Prepared By

HLB DECISION ECONOMICS INC.

**2233 Watt Avenue, Suite 300
Sacramento, CA 95825**

**March 24, 2000
HLB Reference: 6536**

TABLE OF CONTENTS

LIST OF FIGURES	iv
LIST OF TABLES	v
1. INTRODUCTION AND SUMMARY	1
1.1 At Issue: The Choice of Alignment.....	1
1.2 Scope of the Analysis.....	2
1.3 Findings and Conclusions	2
1.3.1 Ridership and Revenue	2
1.3.2 Economic Integration.....	4
1.3.3 Economic Viability (Benefit/Cost Analysis)	5
1.3.4 Construction Cost and Schedule Risk.....	7
1.4 Outline of this Report.....	7
2. RIDERSHIP AND REVENUE	10
2.1 Assessment of Ridership Forecasts	10
2.1.1 Forecast Margin of Error.....	10
2.1.2 Induced Demand	11
2.1.3 Low Value of Access Time.....	11
2.1.4 Value of Small Time Savings	12
2.2 Alignment Length vs. User Access.....	13
2.2.1 Travel Time and Elasticity of Demand	13
2.2.2 Population Growth and Demand for HSR	14
2.3 Ridership Estimates.....	14
2.3.1 Input Assumptions and Methodology	14
2.3.2 Simulation Results	15
2.4 Summary of Findings and Conclusions	18
3. ECONOMIC IMPACTS.....	19
3.1 A Primer on Economic Impact Analysis	19
3.1.1 What are "Economic Impacts"?	20
3.1.2 How Should Economic Impacts be Measured?	20
3.1.3 Choosing the Appropriate Area of Study.....	21
3.1.4 Options for Economic Modeling.....	21
3.2 Residential Development & Economic Growth in Southern California	22
3.3 The Long-Run Economic Impacts of Choosing the Antelope Valley Alignment	25
3.3.1 Input Assumptions and Methodology	25
3.3.2 Simulation Results	27
3.4 Summary of Findings and Conclusions	30
4. ECONOMIC VIABILITY.....	31
4.1 A Primer on Benefit Cost Analysis	31

4.1.1	Economic Benefits and Economic Impacts	31
4.1.2	An Aid for Decision Making	31
4.2	Input Assumptions and Methodology	33
4.3	Benefit Estimates.....	34
4.3.1	Benefits to High-Speed Rail Users	34
4.3.1.1	Intercity Travel	34
4.3.1.2	Urban Travel.....	35
4.3.1.3	Total High-Speed Rail User Benefits	35
4.3.2	Benefits to Non High-Speed Rail Users	36
4.3.2.1	Intercity Travel	36
4.3.2.2	Urban Travel.....	37
4.3.2.3	Total Non High-Speed Rail User Benefits	38
4.4	Indicators of Economic Viability.....	38
4.4.1	Net Present Value.....	38
4.4.2	Benefit Cost Ratio.....	39
4.4.3	Internal Rate of Return.....	42
4.5	Summary of Findings and Conclusions	42
5.	CONSTRUCTION COST AND SCHEDULE RISK	44
5.1	Construction Cost Risk	44
5.1.1	Gradient Issues.....	45
5.1.2	Tunneling Issues	45
5.1.3	Environmental Issues	46
5.1.4	Risk Analysis of Construction Costs	46
5.2	Schedule Delay Risk	48
5.3	Summary of Findings and Conclusions	48
6.	CONCLUSIONS	50
7.	BIBLIOGRAPHY	51
	APPENDIX 1: A Map of the Antelope Valley and the Grapevine Alignments.....	53
	APPENDIX 2: Intercity ridership and revenue forecasts	54
	APPENDIX 3: Express Commuter Ridership Forecasts	56
	APPENDIX 4: Sub-Regional Population and Employment Growth Projections 2000-2020	58
	APPENDIX 5: Freight Statistics for the State of California	61
7.1	Freight in the State of California.....	61
7.2	HSR Benefits.....	Error! Bookmark not defined.
	APPENDIX 6: A Map of the Antelope Valley Region	66
	APPENDIX 7: HLB Economic Simulation Model, Structure and Logic for the Estimation of Long-Run Impacts	68

APPENDIX 8: Brief Overview of Risk Analysis	70
APPENDIX 9: Forecasting Model Structure	74

LIST OF FIGURES

Figure 1: Value of Time Savings	13
Figure 2: Intercity Ridership Forecasts, 2017-2050	16
Figure 3: Risk Analysis of Total Intercity Ridership, 2017-2050	17
Figure 4: Long-Run Employment Impacts from Antelope Valley Alignment.....	28
Figure 5: Long-Run Earnings Impacts from Antelope Valley Alignment	29
Figure 6: Total Long-Run Economic Impacts from Antelope Valley Alignment.....	29
Figure 7: Net Present Value Estimates, Antelope Valley vs. Grapevine.....	40
Figure 8: Construction Cost Risk, Antelope Valley vs. Grapevine	49
Figure 9: SCAG Cumulative Population Growth Projections, 2000 - 2020.....	58
Figure 10: SCAG Cumulative Employment Growth Projections, 2000-2020	60
Figure 11: Los Angeles 60 Mile Circle.....	66
Figure 12: Structure and Logic Diagram for the Estimation of Long-Run Impacts.....	68
Figure 13: Risk Analysis, An Illustration	72
Figure 14: Risk Analysis Results, An Example.....	73
Figure 15: Authority's Model Overview	75

LIST OF TABLES

Table 1: Risk Analysis Adjustment Factors.....	14
Table 2: Risk Analysis of Ridership Projections, 2017 to 2050.....	16
Table 3: Risk Analysis of Revenue Projections, 2017 to 2050.....	17
Table 4: Long Run Development Impact, Input Assumptions	26
Table 5: Long Run Development Impact, Output and Employment Multipliers	26
Table 6: Gross State Product to Employee Compensation Factors	26
Table 7: Long-Run Economic Impact Estimates, Summary Table	28
Table 8: Benefit Cost Analysis Inputs	33
Table 9: Intercity Travel, HSR User Benefits, Most Likely Value	35
Table 10: Urban Travel, HSR User Benefits, Most Likely Value	35
Table 12: Risk Analysis of HSR User Benefits	36
Table 13: Intercity Travel, Non HSR User Benefits, Most Likely Value.....	37
Table 14: Urban Travel, Non HSR User Benefits, Most Likely Value	37
Table 15: Risk Analysis of Non HSR User Benefits	38
Table 16: Net Present Value Estimates.....	38
Table 17: Benefit Cost Ratio Estimates	39
Table 18: Internal Rate of Return Estimates.....	42
Table 19: Comparative Evaluation of Alternative Alignments, Summary.....	43
Table 20: Pros and Cons of the 5% Gradient Option.....	45
Table 21: Tunneling and Construction Cost, Antelope Valley vs. Grapevine.....	46
Table 22: Risk Analysis of Tehachapi Crossing Construction Cost.....	47
Table 23: Risk Analysis of Total Capital Costs, \$1999 Million.....	47
Table 24: Comparative Evaluation of the two Alignments, Summary.....	50
Table 25: 2020 Intercity Ridership Projections, Number of Trips	54
Table 26: 2020 Intercity Passenger Revenue Projections, \$1999.....	54
Table 27: Year 2020 Express Commuter Ridership and Revenue Projections	56
Table 28: Los Angeles County Express Commuter Ridership and Revenue Projections	56
Table 29: SCAG Sub-Region Population Projections	58
Table 30: SCAG Sub-Region Employment Projections.....	60
Table 1: Shipment Characteristics by Mode of Transportation, 1997.....	62
Table 2: Shipment Characteristics by Distance Shipped, 1997	62
Table 3: Freight, HSR User Benefits, Assumptions	64
Table 4: Freight, HSR User Benefits, Most Likely Value.....	64

As with any major investment program, business planning for California's proposed high-speed rail system involves choices and risks. In making selections among many choices, an effective business plan must achieve two purposes: namely, it must maximize opportunities to achieve desired outcomes, and it must minimize risks of undesirable outcomes or of outright failure.

The selection of the system's route alignment is central to the achievement of desired outcomes and to the management of business risk. The two principal alignment options considered by the California High-Speed Rail Authority for crossing the Tehachapi Mountains between Los Angeles Union Station and Bakersfield – the Antelope Valley and the Grapevine – differ principally in relation to (1) length, (2) accessibility, and (3) construction complexity and risk (see Figure ES-1).

First, with respect to length, the Grapevine alignment is some 40 miles shorter than the Antelope Valley alternative and would, therefore, allow a 5 percent (6-9 minute) shorter non-stop travel time between Los Angeles and San Francisco. On the other hand, the Antelope Valley routing would offer high-speed rail service to 350,000 more residents and 150,000 employees than the

Finally, from a construction perspective, while the Grapevine option would, as mentioned, require some 40 fewer route-miles of track construction than the Antelope Valley alignment, this advantage would come at the cost of 17 more route-miles of tunneling through a fault-riddled section of the Tehachapi Mountains, the costliest – and riskiest – type of civil construction that would be encountered on the entire project.

In preparing this analysis, HLB Decision Economics was asked to address two questions, each from a business planning perspective:

- We conclude that the Antelope Valley offers the strongest business case in relation to each of the two questions. Each issue raised in the two questions is addressed in turn, below.

It is well known by rail planners that assessing the trade-offs between length and accessibility to users (number and location of stations) is key to selecting an alignment that will maximize ridership and fare revenue. Whereas a shorter and faster route will attract more passengers than a longer and slower one, a course plotted through heavily populated regions will attract more demand than one through lightly populated and wilderness areas. Our analysis indicates that the additional ridership generated by the greater access to users (residents and employers) under the Antelope Valley option will more than offset the potential ridership advantage of a modestly shorter end-to-end journey time using along the Grapevine alignment. Over the initial project life-cycle period (2017 to 2050), we estimate that total cumulative ridership under the Antelope Valley alternative would exceed that under the Grapevine option by over 3 percent.

The conclusion that passenger demand and revenue from fares are maximized under the Antelope Valley alternative stems from the nature of the potential time savings under the Grapevine option and from the nature of growth patterns in the regions served by the two alignment choices. Studies commissioned by the Authority assume that the average journey time from Los Angeles to San Francisco using the Grapevine alignment would be 2 hours and 30 minutes to 2 hours and 33 minutes. (The range reflects engineering uncertainty about tunnel

However, while the saving in average travel time under the Grapevine option would be between 6 and 9 minutes, 1,400 travelers recently surveyed in southern California (National Cooperative Highway Research Program Report 431, Valuation of Travel Time Savings and Predictability in Congested Conditions) were found to be fully two and a half times more sensitive to variability (uncertainty) in travel time than to differences in average travel time, per se. Whereas the 6 to 9 minute saving in average travel time is less than five percent of the total LA/SF journey time, travel times by high-speed rail in Europe are found to vary from scheduled times by 3 to 5 minutes from one run to another. Thus, when average time savings and running time variability are combined, the impact on ridership of the Grapevine's route length advantage is found to be minimal.

As shown in Figure ES-2, while ridership (and revenue) would initially be higher under a Grapevine-aligned system, this relationship quickly changes in favor of the Antelope Valley option as growth in that region surges at the a rate several times that of the more established urban centers of Los Angeles and the San Francisco Bay Area.

C:\DOCUME~1\BROWN\LOCALS~1\TEMP\653
6PA-1.DOC C:\DOCUME~1\BROWN\LOCALS~1\
TEMP\6536PA-1.DOC C:\DOCUME~1\BROWN\I
OCALS~1\TEMP\6536PA-1.DOC C:\DOCUME~1\
BROWN\LOCALS~1\TEMP\6536PA-1.DOCHLB
DECISION ECONOMICS INC.

1.3.3 Economic Viability (Benefit/Cost Analysis)

The Antelope Valley option offers greater promise of economic benefits that exceed the costs of achieving them. As accurately described by the Authority's ridership and revenue consultant (Charles River Associates) the benefits of high-speed rail would occur in the form of travel time savings and vehicle operating cost savings for rail passengers and for remaining highway and aviation users; reduced loss of life, injuries, and property damage in highway accidents; and diminished volumes of air pollutants and greenhouse gases. Over its first 33 years of operation, a high-speed rail system employing the Grapevine alignment has been estimated to generate as much as \$22.7 billion of economic benefit over and above the capital and operating costs of achieving these benefits (present value in 1999, in dollars of 1999 purchasing power). We estimate that the Antelope Valley alignment would generate an additional \$.9 billion in net benefits above that expected under the Grapevine alternative (see Table ES-1).

It is noteworthy that the Antelope Valley alignment offers greater economic returns to the state of California in spite of the possibility that the Grapevine alternative could generate about 3.8 percent lower capital and operating costs. As discussed below, lower costs under the Grapevine option would occur only if the savings associated with building 41 fewer route miles offset the expense of the extra 17 miles of tunneling. While considerable uncertainty attaches to the true nature of this trade-off, the Antelope Valley would nevertheless generate stronger economic returns under even the most optimistic assumptions regarding the cost of tunneling across the Grapevine.

Table ES-1: Comparative Evaluation of Alternative Alignments, Summary

	Antelope Valley	Grapevine	Difference
Passenger Revenue ⁽¹⁾	\$9,718	\$9,651	\$67
User Benefits			
Intercity	\$8,504	\$8,519	-\$15
Urban ⁽²⁾	\$350	\$317	\$33
Subtotal User Benefits	\$8,854	\$8,835	\$18
Nonuser Benefits			
To Intercity Travelers ⁽³⁾			
Airline Passenger Delay	\$8,055	\$7,765	\$290
Aircraft Operating Delay	\$4,422	\$4,283	\$139
Highway Delay	\$3,772	\$3,540	\$232
Highway Accident Cost	\$782	\$780	\$2
Highway Air Pollution	\$103	\$103	\$0
Subtotal	\$17,133	\$16,471	\$663
To Urban Travelers ⁽⁴⁾			
Highway Delay	\$9,817	\$8,822	\$995
Highway Accident Cost	\$360	\$326	\$34
Highway Air Pollution	\$48	\$43	\$4
Subtotal	\$10,225	\$9,192	\$1,034
Subtotal Nonuser Benefits	\$27,359	\$25,662	\$1,696
Total Benefits	\$45,921	\$44,149	\$1,773
Costs			
Capital Costs	-\$15,971	-\$15,443	-\$528
Operating and Maintenance Costs	-\$6,329	-\$6,015	-\$314
Total Costs ⁽⁵⁾	-\$22,300	-\$21,458	-\$842
Net Present Value	\$23,621	\$22,690	\$931
80% Confidence Interval			
Lower Bound	\$21,123	\$21,431	-\$308
Upper Bound	\$26,384	\$23,385	\$2,999

All Dollar Amounts in PRESENT VALUE of \$1999 Million

(1) Does not include revenue from express commuter services

(2) *Benefits to HSR express commuters*

(3) *From diversion of intercity travelers to HSR*

(4) *From diversion of intercity travelers AND commuters to HSR*

(5) Does not include cost of providing express commuter services

1.3.4 Construction Cost and Schedule Risk

Apart from general ridership and revenue risk, the principal business risks facing the California High-Speed Rail Authority pertain to construction period capital outlay and project schedule. Risk analysis of the engineering factors that underlie the choice between the Antelope Valley and the Grapevine alignment options suggest that both risks are minimized under the Antelope Valley choice.

The risk analysis of capital expenditure revolves principally around the uncertainty associated with achieving optimal tunnel gradients through Tehachapi Mountains under the Grapevine option. Whereas five percent grades would minimize train running times, current high-speed train technology tend to perform optimally at no more than three percent gradients. As shown in Figure ES-3, if engineering "planning assumptions" are achieved, there is a 50 percent probability that the Grapevine option could generate capital costs that lie 1.7 percent below the expenditure required under the Antelope Valley alternative. The sizeable excavation and tunneling risks also mean, however, that the Grapevine option could become as much as \$400 billion more expensive than the Antelope Valley alternative.

Excavation and tunneling also bring schedule risk. Unexpected or unplanned additions to earthwork, sub-grade construction and tunneling are the principal causes of slippage against project schedules. The Grapevine option thus presents a substantially greater risk of project schedule delay than does the Antelope Valley alternative.

1.4 Outline of this Report

The report is organized as follows. Chapter 2 summarizes HLB's ridership and revenue projections under the two competing alignments. Chapter 3 explores the potential economic impacts - or economic development - associated with choosing the Antelope Valley option. Chapter 4 investigates the economic viability of the project under the two proposed routes through a detailed benefit-cost analysis. Finally, Chapter 5 introduces a risk analysis of construction costs and schedule delays; the chapter helps determine, in particular, which of the two alternatives is more likely to cause schedule slippages and budget overruns. The report ends with a brief conclusion and various appendices.

Figure ES-3: Capital Cost Risk along the Tehachapi Crossing, 1999 \$Millions

2. RIDERSHIP AND REVENUE

This chapter summarizes HLB's findings concerning the ridership and revenue projections under the two competing alignments. It comprises two main sections. The first section addresses the uncertainty in ridership forecasting. It points out reasons why the ridership-forecasting model used by the Authority¹ is likely to underestimate intercity ridership associated with the Antelope Valley option. This section borrows heavily from HLB's 1998 report. The second section of the chapter investigates the tradeoffs between length or travel time on one hand and accessibility of users (number and location of stations) on the other hand. It is well known by rail planners that assessing these trade-offs are key to selecting an alignment that will maximize ridership and fare revenue. Whereas a shorter and faster route will attract more passengers than a longer and slower one, a course plotted through heavily populated regions will attract more demand than one through lightly populated and wilderness areas.

2.1 Assessment of Ridership Forecasts

According to the Authority, choosing the Antelope Valley alignment would result in the loss of approximately one million passengers, or nine percent of total ridership. This nine percent decrease in total ridership would be caused primarily by a six- to nine- minute increase in total travel time (less than five percent of total trip time). Several key features of the ridership-forecasting model, however, do not point to any definitive judgments on the relative ridership estimates of alternative high-speed rail alignments. These features and their impact on alignment choice are summarized below.

2.1.1 Forecast Margin of Error

Typical intercity rail demand models have an error range of 20 percent.² Even the best models that are calibrated using “before” and “after” data have errors associated with them. These errors are attributable to various sources:

- Sampling fluctuations: any projection based on inferential techniques (where a sample is used to derive information about the population of interest, e.g. surveys and travelers' interviews) contains margins of error.
- Uncertainty surrounding the forecasting assumptions: population growth, future travel costs, household income or travelers' preferences (to name a few) may diverge from their projected path.
- Statistical robustness of the model: a model is said to be robust when it is relatively insensitive to slight violations in the underlying assumptions/environment. A model extremely sensible to small violations will produce larger "errors", other things equal.

¹ See Appendix 9 for an overview of the model structure

² "Signals Model: British rail Analysis of Forecasts for 29 Intercity Rail Investment Programs", London, 1985. This study, like the others cited in the footnotes, is used throughout this discussion.

Again, with a forecasting horizon of 30 years (or more) in the future, no model can claim accuracy -- even with "certain" forecasting assumptions -- within 20 percent. Forecasting models are useful in choosing between alternatives when outcomes differ by an order of magnitude larger than this margin of error. As it appears, the nine percent difference in intercity ridership lies within the forecasting margins of errors; in other words, this nine percent difference is not statistically significant.

2.1.2 Induced Demand

The Authority's ridership study estimates induced demand of five percent of total HSR demand.³ Most studies show the impact of induced demand to be significantly higher than five percent -- more in the range of thirty to fifty percent. This could have a major impact on both total ridership and ridership originating in communities that are more likely to be affected by the introduction of a "new" mode, such as the Antelope Valley.

The induced demand model is constrained, in particular, by the definition of inter city trips, set to 80 miles or greater.⁴ Adjusting this assumption could have a significant impact on induced demand estimates. Induced demand is indeed highly correlated with distance, with longer travel distances generally having lower levels of induced demand. Since the trip length of induced trips is much shorter than the average length of intercity trips, it is likely that locations (such as the Antelope Valley) in the vicinity of major urban areas would benefit most from a greater focus on induced demand. Besides, given the shorter distances to Los Angeles and the Bay Area from the Palmdale station (as opposed to Los Angeles or Santa Clarita to the Bay Area), induced demand under the Antelope Valley option would probably be higher than current estimates indicate.

2.1.3 Low Value of Access Time

The forecasting model developed by the Authority tends to underestimate access and egress costs. The underestimation of access costs leads to an overestimation of the potential riders from the Antelope Valley region, which would be retained in the absence of a Palmdale station.

In the model developed by the Authority, the value of access time seems low compared to what other studies have used or recommended. The economic literature shows that the value of access time should be in the range of thirty to a hundred percent higher than the value of line haul time.⁵ Such values were not found in the model: the model tends to overstate travelers' willingness to drive to alternative stations when there is no station nearby. In particular, the Authority's model suggests a greater willingness for Antelope Valley residents to drive to Bakersfield or Santa Clarita than would actually be the case. Correcting this omission would reduce the Grapevine ridership forecasts.

³ See Charles River Associates *Ridership Study*, Table 6-3.

⁴ The Palmdale distance to LA is 71 miles and is therefore not considered in the ridership analysis. Potential Antelope Valley riders are included in the Grapevine alignment because the auto trip plus the rail trip to destinations north is greater than eighty miles.

⁵ "Value of Time in Transportation Planning", Harrison and Quamby, ECMT, Paris, 1969 and "Analysis of Values of Time in the Toronto-Montreal Corridor for VIA Rail", TEMS, Montreal, 1995

The Authority's analysis also assumes that under the Grapevine alternative about 50 percent of the riders who would have boarded the train in Palmdale would board it in Santa Clarita instead. This retention rate is too high given the level of road congestion between Palmdale and Santa Clarita. It should be noted that travelers choose rarely to drive backwards to take a train, particularly on congested roadways: individuals from Palmdale going to San Francisco would drive to Bakersfield, not Santa Clarita. Why? On the homeward journey, people who drove to Bakersfield can leave the train earlier and drive the last leg home. This means that ridership and revenue for the Grapevine option could be somewhat lower than projected.

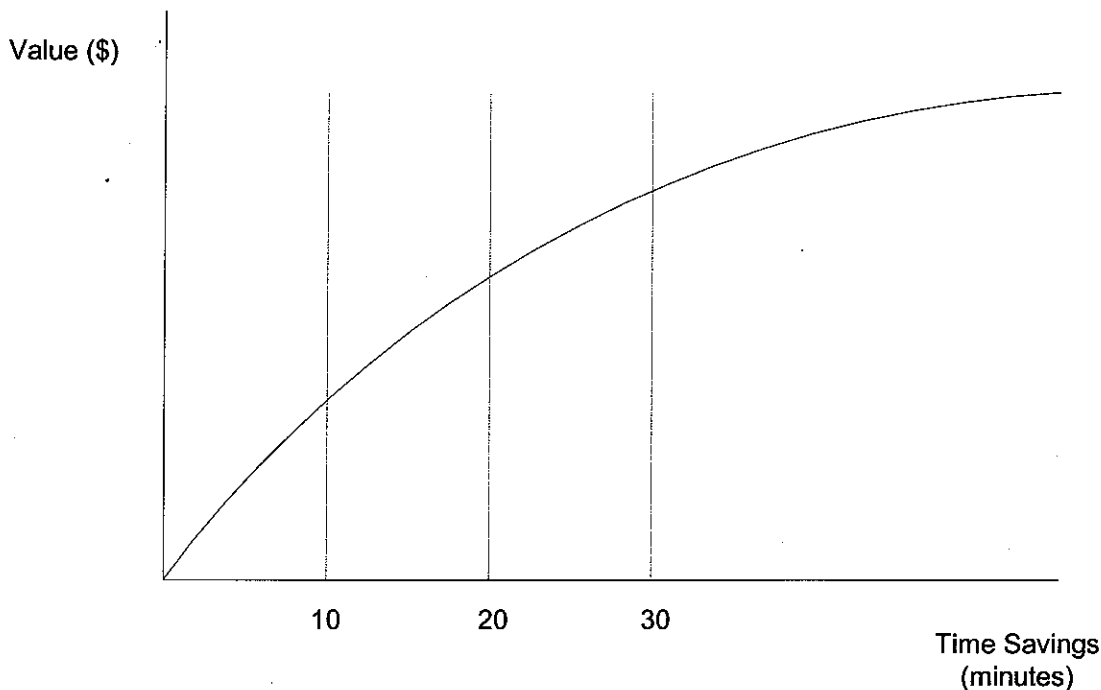
2.1.4 Value of Small Time Savings

The assumption that small travel-time savings (i.e., less than ten minutes) are equal "in value" to large time savings (i.e., greater than thirty minutes) overestimates the sensitivity of travelers to changes in total rail time between San Francisco and Los Angeles. This leads to an underestimation of the number of through (e.g., SF-LA) passengers who would use high-speed rail under the Antelope Valley alternative.

In general, time savings below ten minutes are considered much less valuable than savings in excess of ten minutes. As the amount of time saved approaches zero, the value assigned to such savings also approaches zero. Figure 1 represents this relationship. The literature suggests that time savings below ten minutes should be valued at about one-half the rate of savings above ten minutes.⁶ The time saving associated with the Grapevine option is six to nine minutes. For small time savings (i.e., time savings under ten minutes), research has shown that individuals have difficulties perceiving the saving. As a result, the demand impact of the extra rail time under the Antelope Valley option would be less than what the Authority's model predicts. Again, this reduces the volume and revenue differences between the two alignments.

⁶ London Third Airport Study (Royal Commission). TEMS study for VIA Rail.

Figure 1: Value of Time Savings



The above issues, when combined, do not indicate the superiority of any alignment over the other. If these issues, and the quantitative evidence supporting them, are used to develop a risk assessment of the range of potential outcomes, then the Antelope Valley alignment becomes comparable with, if not superior to the Grapevine alignment. This is explained below.

2.2 Alignment Length vs. User Access

Our analysis indicates that the additional ridership generated by the greater access to users (residents and employers) under the Antelope Valley option would more than offset the potential ridership advantage of a modestly shorter end-to-end journey time along the Grapevine alignment. Over the initial project life-cycle period (2017 to 2050), HLB estimates that total cumulative ridership under the Antelope Valley alternative would exceed that under the Grapevine option by over 3 percent.

The conclusion that passenger demand and revenue from fares are maximized under the Antelope Valley alternative stems from the nature of the potential time savings under the Grapevine option and from the nature of growth patterns in the regions served by the two alignment choices.

2.2.1 Travel Time and Elasticity of Demand

Studies commissioned by the Authority assume that the average journey time from Los Angeles to San Francisco using the Grapevine alignment would be 2 hours and 30 minutes to 2 hours and

33 minutes. (The range reflects engineering uncertainty about tunnel gradients – see risk analysis below). The same journey under the Antelope Valley alternative would take, on average, an estimated 2 hours and 36 minutes to 2 hours and 39 minutes. However, while the saving in average travel time under the Grapevine option would be between 6 and 9 minutes, 1,400 travelers recently surveyed in southern California (National Cooperative Highway Research Program Report 431, *Valuation of Travel Time Savings and Predictability in Congested Conditions*) were found to be fully two and a half times more sensitive to variability (uncertainty) in travel time than to differences in average travel time, per se. Whereas the 6 to 9 minute saving in average travel time is less than five percent of the total LA/SF journey time, travel times by high-speed rail in Europe are found to vary from scheduled times by 3 to 5 minutes from one run to another. Thus, when average time saving and running time variability are combined, the impact on ridership of the Grapevine's route length advantage is found to be minimal.

2.2.2 Population Growth and Demand for HSR

The second factor driving higher ridership and revenue under the Antelope Valley option above that of Grapevine is the pattern of population and employment growth. Whereas the routing along the Grapevine would cross areas of wilderness and lightly populated rural districts, the Antelope Valley alignment would serve an established growth path for population and industry in the region. As a key national growth pole for aerospace and other high technology industrial expansion, the Antelope Valley is projected to witness a rate of annual population and employment growth three to four times that of the state overall. Resident population in the Antelope Valley is expected to swell from 360,000 today to some 700,000 by 2020, the implementation and initial ramp-up period for high-speed rail system.

2.3 Ridership Estimates

The ridership estimates presented in this report are based on the Authority's estimates⁷ adjusted for the comments and findings summarized in Sections 2.1 and 2.2. They are developed in a risk analysis environment⁸ that accounts for the uncertainties highlighted above.

2.3.1 Input Assumptions and Methodology

The table below summarizes the key input assumptions underlying HLB's intercity ridership and revenue projections.

Table 1: Risk Analysis Adjustment Factors

	Median	Lower 10%	Upper 10%
Average HSR Speed along Tehachapi Crossing (Mph)			
Antelope Valley Alignment	159	151	167

⁷ See Appendices 2 and 3

⁸ See Appendix 8 for a brief description of Risk Analysis

Grapevine Alignment	137	124	151
Travel Time Elasticity of Demand	-0.80	-1.20	-0.40
Antelope Valley Long-Run Population Growth			
Acceleration Starts in Fiscal Year	2020	2020	2020
Annual Population Growth Adjustment Factor	+0.50%	+0.25%	+1.00%

Average Speed along the Tehachapi crossing: There is more uncertainty (more down-side risk) in the average speed estimate for the Grapevine alternative. Ridership projections must account for this uncertainty.

Travel Time Elasticity of Demand: Because travel demand results from several travel decisions, the elasticity of demand changes over time. Changes in regional socio-economic conditions, in particular, alter this elasticity. Such variations must be accounted for in the analysis. The ridership estimates presented below are based on elasticity estimates that reflect recent empirical findings.

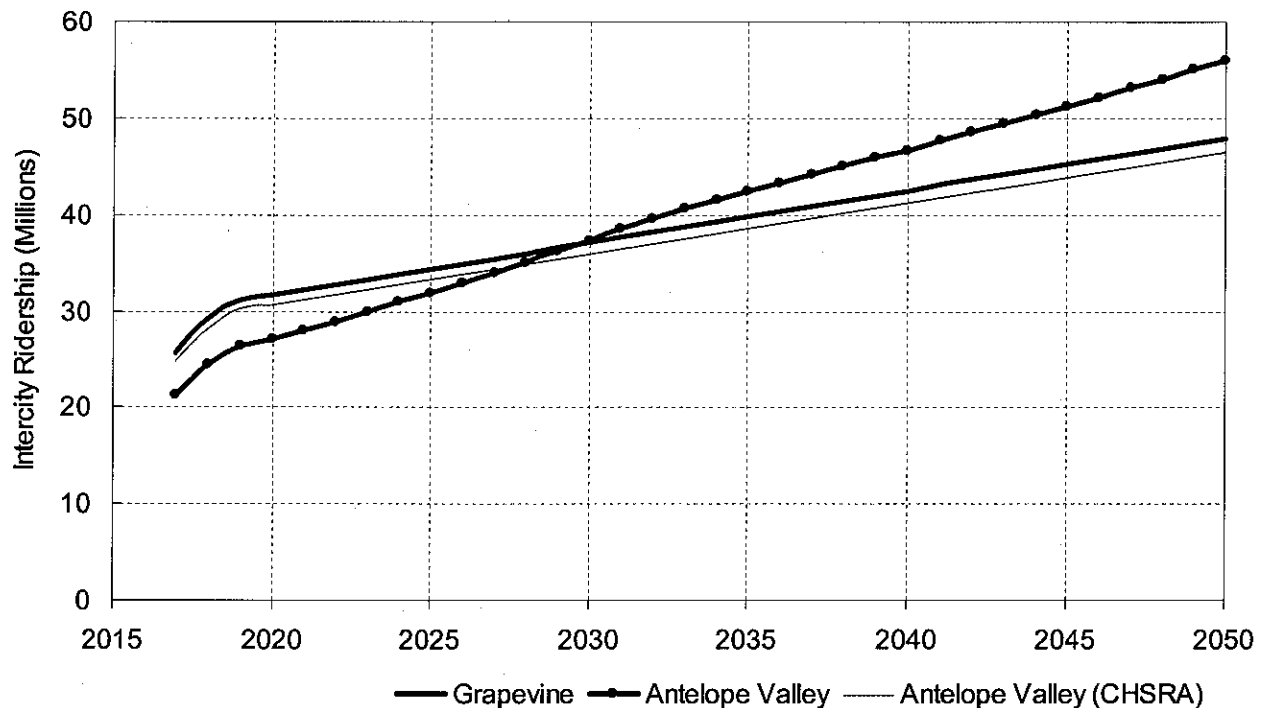
Palmdale-Station Effect, Access Time and Long-Run Development: the presence of a station in the City of Palmdale would reduce access time for a large (and growing) portion of the L.A. county population. It would also generate significant residential and industrial development in the Antelope Valley region, the only area of Southern California that can sustain significant demographic growth in the coming years. As explained in HLB's 1998 study, these two factors were not taken into account in the Authority's estimates.

The median, lower 10% and upper 10% values for the Annual Population Growth Adjustment Factor (last row of the Table) reflect the range of possible ridership impact of adding the Palmdale station to the High Speed Rail network and the potential population and employment growth based on SCAG forecast. If the population and the economy of the Antelope Valley region grows as expected (i.e. at a rate about four times larger than the growth rate of the Los Angeles statistical area), the Palmdale station may become a major destination for Californian travelers. This possibility was not accounted for in the ridership forecasts prepared by the Authority.

2.3.2 Simulation Results

HLB adjusted ridership growth estimates over the years based on the above factors. It appears that during the first 15 years of operations, the Grapevine alignment may result in higher ridership than the Antelope Valley alignment. However, as explained in the previous section, the Antelope Valley alignment is expected to show higher ridership growth in the following years due to the expected residential and industrial growth in the region. This growth in intercity ridership from and to the Antelope Valley will more than offset the minimal loss of intercity ridership due to the 6 to 9 minutes travel time difference. Figure 2 below shows the ridership forecast by alignment between fiscal year 2017 and 2050.

Figure 2: Intercity Ridership Forecasts, 2017-2050



The curve labeled "Antelope Valley (CHSRA)" - below and almost parallel to the Grapevine curve - shows intercity ridership under the Antelope Valley option as projected by the Authority. The curve was derived on the basis of the travel time difference between the two options and a constant travel-time elasticity of demand in line with that employed by the Authority's consultant. The curve remains below the Grapevine curve because it fails to fully account for the impact of demographic growth and economic development in the Antelope Valley region.

Table 2 below summarizes the results of conducting a risk analysis for intercity ridership projections. Note that the confidence interval for the Antelope Valley is wider given the uncertainty surrounding the true future population and economic growth in the region.

Table 2: Risk Analysis of Ridership Projections, 2017 to 2050

	Mean	80% Confidence Interval	
		Lower Bound	Upper Bound
Intercity Ridership (Million Trips)			
Antelope Valley	1,372	1,283	1,472
Grapevine (5%)	1,317	1,284	1,346
Percentage Difference	4.2%	0.0%	9.4%

* Based on a "normal" interval of fluctuation defined as: Mean plus or minus twice the standard deviation.

Figure 1 is a line graph showing the probability of exceeding a certain value (Y-axis, 0.0 to 1.0) versus a value (X-axis, 1,200 to 1,600). Two curves are plotted: Grapevine (solid line) and Antelope Valley (line with dots). The Grapevine curve is steeper and reaches a probability of 0.0 around 1,368. The Antelope Valley curve is flatter and reaches a probability of 0.0 around 1,532. A vertical dashed line is drawn at 1,321, labeled '1,321'.

Value (X-axis)	Grapevine Probability (Y-axis)	Antelope Valley Probability (Y-axis)
1,220	0.98	0.98
1,250	0.95	0.95
1,280	0.85	0.90
1,300	0.65	0.85
1,321	0.45	0.80
1,340	0.25	0.70
1,368	0.05	0.60
1,380	0.00	0.50
1,400	0.00	0.40
1,420	0.00	0.30
1,440	0.00	0.20
1,470	0.00	0.10
1,500	0.00	0.05
1,532	0.00	0.00

Table 3: Risk Analysis of Revenue Projections, 2017 to 2050

	Mean	80% Confidence Interval	
		Lower Bound	Upper Bound
Intercity Revenue, PV \$1999 Million			
Antelope Valley	9,718	9,172	10,285
Grapevine (5%)	9,610	9,363	9,818
Percentage Difference	1.12%	-2.05%	4.76%

Is the Difference Statistically Significant?	No		
--	----	--	--

2.4 Summary of Findings and Conclusions

The additional ridership generated by the greater access to users (residents and employers) under the Antelope Valley option would more than offset the potential ridership advantage of a modestly shorter end-to-end journey time along the Grapevine alignment.

An additional element of the Antelope Valley alignment, which is key to the choice among alternative alignments, is the potential for high-speed rail to generate long-term economic development impacts. The economic, demographic and physical characteristics of the Antelope Valley community are ideal to foster high-speed rail based economic development activity in the state of California. Evaluating this potential development is the purpose of the next chapter.

3. ECONOMIC IMPACTS

This chapter investigates the potential economic impacts associated with the Antelope Valley high-speed rail alignment in California. The approach and results presented here were developed with full recognition of the problems associated with measuring benefits such as the validity of the methodology, the definition of the geographic study area, the appropriateness of the multiplier effects, and the estimation of benefits as incremental rather than a transfer within the state.

HLB's 1998 report evaluated three components of economic development potential for high-speed rail in the Antelope Valley. The first estimated the potential for the Antelope Valley and high-speed rail to attract individuals and families to the community. Antelope Valley is one of the few regions in the greater Los Angeles area that can support residential and industrial growth. The second component was the direct and indirect economic impacts associated with high-speed rail station development at the Palmdale airport. The third component evaluated the potential for the Antelope Valley alignment to either retain or attract new industry to the state of California. All of these economic benefits to the state of California would be lost without the Palmdale station. Forgoing these impacts jeopardizes the overall assessment of high-speed rail in California.

3.1 A Primer on Economic Impact Analysis ⁹

Economic impacts associated with a new transportation investment are in some cases transfers from one county to another or from one state to another. In this sense, the investment does not generate an incremental change in economic activity. In addition, the economic impacts associated with the building of the new transportation infrastructure are typically short term in nature.

With all of these limiting factors in mind, the proposed methodology measures the incremental impact of locating high-speed rail in the Antelope Valley versus the Grapevine. The methodology accounts for the amount of economic activity that is new to California rather than transfers from other regions, and it develops an explicit link between the transportation improvement (high-speed rail) and new economic activity. Therefore, the methodology does not include the short run impacts associated with the construction of the alignment in the region and the station development at Palmdale.

The economic impact methodology relates to the potential for long run incremental economic activity in California as a result of adopting the Antelope Valley alignment. This incremental activity is generated principally by individuals who choose to locate in the Antelope Valley region as a result of better access to Los Angeles, San Francisco, and intermediate points.

It is also highly likely that businesses will choose to locate in the Antelope Valley following the introduction of high-speed rail. Business location decisions are complex and difficult to model because of the interaction of all the factors influencing a location decision. By isolating the

⁹ This part draws heavily from Weisbrod, Glen and Burton Weisbrod, "Measuring Economic Impacts of Projects and Programs," *Economic Development Research Group*, April 1997.

analysis on the behavior of individual travelers and the ability of the community to absorb future housing and employment growth, the methodology does not over attribute economic impacts to high-speed rail in Antelope Valley. In this sense, the results likely represent a minimum in terms of new economic activity that could be generated with the addition of the Palmdale station.

Economic impacts are effects on the level of economic activity in a given area, as measured in terms of (1) business output - sales, (2) profits, (3) value added, (4) wealth, (5) property values, (6) income, and (7) jobs. This is different from individual "user" impacts of a particular facility or service, and it is different from broader "social" impacts (which may include the valuation of changes in factors affecting quality of life such as time savings, comfort, convenience, safety, air quality, health, etc.). The social impacts may be valued in economic (money) terms through studies of individuals' or society's "willingness to pay" for improving them, or through other measures. However, they are not economic impacts (as defined above) unless they affect an area's level of economic activity.

3.1.1 What are "Economic Impacts"?

Economic development impacts can be broken down into direct, indirect, and induced impacts.

- Direct impacts are those impacts directly attributable to the initial investment;
- Indirect impacts result from the spillover effects in the markets for intermediate goods;
- Induced impacts result from the spending and re-spending of dollars earned by individuals who become employed as a result of the initial investment.

The "indirect" and "induced" business impacts of a program, project, or facility are often referred to as "multiplier effects," since they can make the overall economic impacts substantially larger than the direct effects alone. In reality, while indirect and induced impacts do always occur, the net impact on the total level of economic activity in an area may or may not be increased by multiplier effects. That outcome depends on the definition of the study area and the ability of the area to provide additional workers and capital resources, or attract them from elsewhere. Typical multipliers are defined as follows:

- Output multiplier is the total overall increase in dollars of business output for all industries per dollar of additional final demand (purchases) of the given industry in that area.
- Job multiplier is the total overall increase in jobs for all industries per new job created in the given industry.

3.1.2 How Should Economic Impacts be Measured?

The Appropriate measure of economic impact depends on the purpose of the analysis. In our case, the study is aimed at estimating the expected future impacts of the high-speed rail project on the Antelope Valley region. For this kind of study, potentially all of the different aspects of economic impact (reflected in the various measures listed above) can be relevant. However, to avoid double counting, the valuation of multiple measures of economic impacts should normally not be added together.

3.1.3 Choosing the Appropriate Area of Study

There is no subject that causes more error or confusion in economic impact analysis than the selection of the appropriate geographic area of study. The fundamental reason is that, depending on how the geographic area is defined, certain economic effects will either be internal or external to the area, the distribution of gainers and losers will differ. From the viewpoint of a city jurisdiction, business expansion and business relocations from outside to inside the city will be seen as a benefit, but shifts within the city - gains in one part of the city being offset by losses in other parts of the city - will not be seen as a net overall benefit.

From the viewpoint of a state jurisdiction, business expansion and relocations from outside to inside the state will be seen as a benefit, but shifts within the state will not be seen as a benefit. Productivity improvements, however, resulting from transportation project such as high-speed rail, will still be seen as a benefit. Furthermore, the access to the Antelope Valley through high-speed rail broadens the area of direct project influence and favorably impacts the rest of the State.

3.1.4 Options for Economic Modeling

Economic models can be used to forecast personal income, employment, business sales, and value added impacts. The available models represent a continuum of sophistication and cost, so it is prudent to match the economic model to the problem at hand.

Input / Output Models

These are essentially accounting tables which trace the linkages of inter-industry purchases and sales within a given county, region, state or country. They utilize information on both technologies ("What inputs from other industries are used to produce a dollar of product for each specific industry?") and local trade ("How much of a given industry's purchases are supplied by other firms located within the study area?"). The I/O model yields "multipliers" that are used to calculate the full (direct, indirect, and induced) jobs, income, and output generated per dollar of spending on various types of goods and services in the study area. However, I/O models have significant limitations. Used alone, they assume that there are no impacts on wage levels, property values, prices or costs of other product inputs or outputs, no change in labor or capital productivity (the ratio of output per unit of input), and no change in population or business in/out migration patterns. They also do not distinguish the period of time over which the estimated impacts occur.

Economic Simulation Models

These are "econometric" and "general equilibrium" models - sophisticated computer programs that trace the total effects over time of changing economic conditions in a study area. They include all of the functions of I/O models, plus additional functions to forecast effects of future changes in business costs, prices, wages, taxes, productivity, and other aspects of business competitiveness, as well as shifts in population, employment, and housing values. Simulation models, as I/O models, can be directly applied to estimate the full income and job effects of business location, industry activity, and spending shifts. Unlike I/O models, they may also be used to estimate the further effects over time of changes affecting relative costs, prices, productivity, business competitiveness, and population in/out migration.

A simulation model calibrated for the Antelope Valley region has been developed for the present study. The model estimates the Long-Run Economic Impact model associated with choosing the Antelope Valley Alignment vs. the Grapevine Alignment. Transportation investments affect the attractiveness of an area for population growth and retention, and for business investment and retention. The direct economic effect is the change in local economic activity occurring as a result of these changes. Indirect economic effects include trade and services at the retail, wholesale and producer levels. Induced effects include the consequences of the change in workers and payroll of indirectly affected businesses (added income and workers in the retail sectors, etc.).

3.2 Residential Development & Economic Growth in Southern California

The economic, demographic and physical characteristics of the Antelope Valley are such that the development of high-speed rail could have a measurable impact on economic growth. This becomes most likely when dynamic and fast growing communities, such as Palmdale, Santa Clarita, Lancaster, and Bakersfield, are provided with links to large metropolitan centers such as Los Angeles and San Francisco. Connecting these communities is not only positive in terms of the viability of the rail line itself but also in terms of the impact on the statewide economy.

To the extent that new transportation links improve the performance of the state economy, these improvements are more than just a one-time injection of economic activity into a region. New transportation improves the efficiency with which labor and goods move throughout the economy, and they bring communities closer together. As such, the impacts are dynamic and long run.

The methodology for estimating long run economic development impacts from the Antelope Valley is described below. This methodology is based on the potential for residential development and economic growth in Southern California. This will ultimately be supported by a mix of new industries in the local communities and in the metropolitan centers for which access has improved.

The principal economic mechanism by which the Antelope Valley alignment for HSR will generate economic growth for California is by improving access from points north and south to affordable land and housing suitable for residential development.

Land and Housing as Growth Constraints

One of the principal constraints on economic development in Southern California is the high price of housing compared to other metropolitan areas with which Southern California competes. This forces employers and population to shift to lower housing cost areas such as Arizona or Colorado. High priced housing is largely driven by the shortage of residential land in the Los Angeles area. There is relatively little land left suitable for residential development within a reasonable distance of the key employment centers in the central part of the region. The finite nature of land has an important impact on the relationship of transportation and economic growth strategy. Any strategy to increase economic growth, whether implemented by the public or private sectors, will be limited in its ultimate effects. As a particular sector grows, and the

number of employees increases, these employees will add to the demand for and thus the price of housing. This will serve to displace jobs in other sectors.

Development Scenarios

If, in the extreme case, greater Los Angeles has completely exhausted its supply of residential land and there is no possibility of increasing the average density of development by increasing the number of housing units per acre, then any employment gains in one sector would result in one-for-one losses in other sectors due to limits to housing availability.

This extreme scenario is unrealistic for the following reasons. There is some potential to increase housing density in Los Angeles by further shifts to townhouses and apartments. Some employers can shift operations to locations on the periphery of the metropolitan area closer to vacant land, which may be too distant for travel to the more central locations.

Many industries cannot readily shift to an "edge city" location more distant from supporting services, international air service, and other key locational factors. There may be other constraints limiting the growth of the "edge city" locations. Lifestyle preferences will limit the shift away from single-family homes. In addition, there are institutional constraints that make it difficult to increase density.

By developing an HSR link to the Antelope Valley, which is suitable for timely travel to Los Angeles, San Francisco and intermediate points, this development constraint is altered. More land can be brought within reasonable distance of the central Los Angeles region because of the improved access, thus increasing the potential of the region to support additional job growth. Much of the available land in the Antelope Valley is not currently within commuting distance to Los Angeles with the congestion on SR14. Additionally, access to cities in the central valley and San Francisco is extremely limited.

Proposed improvements to SR14 are unlikely to significantly alter this picture. HSR thus allows the greater Los Angeles economy to fully leverage the land resources of the Antelope Valley, and, thus plays a strategic role in the Los Angeles economy. It can only do this with a station serving the areas with available land. The Antelope Valley alignment is the only available alternative capable of this development.

Antelope Valley Economic Outlook

The Antelope Valley is located in the westernmost part of the Mojave Desert, and is approximately 3,000 square miles in size. On the northwest, the Valley is separated from the San Joaquin Valley by the Tehachapi Mountains. On the south and southwest, it is delimited by the San Gabriel Mountains. The north and east boundaries of the Antelope Valley are distinguished by isolated buttes.

Because of the Antelope Valley's unique air corridors and excellent flying weather, the Air Force and NASA have chosen it as a location for important aviation/aerospace research. The major industry in the Antelope Valley is in fact aerospace, with three large firms — Boeing, Lockheed Martin Skunk Works, and Northrop Grumman — clustered at Plant 42 in Palmdale. Other smaller aerospace employers — like Rotary Rocket — are at the Mojave Airport.

While a significant number of jobs are concentrated in the aerospace industry, other types of manufacturing are also thriving in the Valley¹⁰. In Palmdale, Senior Systems Technology manufactures and assembles electrical components for a variety of customers, and Anderson Barrows, which makes plumbing parts, is rapidly expanding. In Lancaster Deluxe Financial Services produces checks and financial documents, and Rexhall Industries and Lance Campers manufacture recreational vehicles. Simulation Plus and Words+ makes computer hardware and software that allow severely disabled people to communicate and move about. Hollywood production companies are shooting films, TV programs and commercials in increasing numbers around the Valley.

Building hundreds of new houses continues to be a major segment of the economy of the area; 393 new homes were built in Lancaster in 1997-98, and 394 in Palmdale. One of the oldest industries is mining, dating back to the 1800s when the mule wagons carried borax across the desert to the Mojave trains. U.S. Borax continues to mine borax today, and the Golden Queen Mines between Rosamond and Mojave is producing gold ore. Cement manufacturers include California Portland Cement, Calavares Cement and National Cement.

Historically, agriculture has been a major sector in the local economy; however, growing population and costs of water have encroached on the ranches over the past few decades. Growing crops such as carrots, onions, peaches, pears, apples, cherries and alfalfa continue to reap millions for farmers in the Valley.

Although the area is known for its "bedroom communities," the number of local jobs is increasing. In fact, recent hiring studies by Manpower and the Lancaster Chamber of Commerce reported that 53 percent of local businesses have hired new workers during 1999. Senior Systems Technology, an electronics manufacturing company in Palmdale, expects to be hiring more workers soon, and Michaels Arts & Crafts and Rite Aid distribution centers opening in Lancaster will be looking for hundreds of workers. The school districts, county and city government agencies, prisons, and hospitals are also major employers.

The Palmdale Regional Airport could play a key role in the future development of the region. A recent study on the possible future use of the airport¹¹ showed that it could attract as many as 4 million domestic passengers a year by 2010. The study was commissioned by Los Angeles World Airports, which owns and operates the airport. Among other things, the study assumed: the construction of a new airline terminal at Palmdale Regional Airport; the routing of the high-speed rail line through the Antelope Valley; the improvement of existing roadways and construction of new ones to Santa Clarita, Bakersfield and Victorville and the growth in population as projected by agencies such as the Southern California Association of Governments. Reopening the airport and making it a regional facility would alleviate a significant portion of the future load anticipated at Los Angeles International Airport. The load is expected to increase from 60 million to 98 million air passengers annually by 2015. If Palmdale were to serve 4 million people, it would be handling about 4% of the region's total domestic air-passenger service demand.

¹⁰ This information is obtained from the Palmdale Library and the Greater Antelope Valley Economic Alliance.

¹¹ Wilson, Bob, "Regional airport to handle millions if...", the Antelope Valley Press August 21, 1999.

3.3 The Long-Run Economic Impacts of Choosing the Antelope Valley Alignment

Appendix 7 at the end of this report presents the structure and logic of the methodology used to estimate long run economic impacts associated with a station located in Palmdale, linking the Antelope valley to San Francisco, Los Angeles and other major Californian cities.

3.3.1 Input Assumptions and Methodology

Several factors contribute to the estimation of these impacts. First, the maximum potential development impact is determined by estimating the number of households that could be accommodated within a reasonable distance of the Palmdale station. This is further constrained by the total land area brought within reasonable distance/time of Los Angeles.¹² Next, we forecast future residential density under a full development scenario. The current population of the commuter zone is subtracted from future population forecasts to derive the potential long run impact in terms of added households.

This base number of households is further adjusted to reflect estimated HSR ridership to and from Palmdale. That is, an individual relocating to Palmdale who does not use the HSR services would not be included in the economic impact calculations associated with the rail line. We further reduce this figure to reflect the fact that some of the new riders/residents are not genuinely incremental to California, but represent a shift of population from other parts of California.

Having arrived at an estimate of the new households associated with the Antelope Valley HSR alignment, we multiply by the number of employees per household and average income by sector to obtain employment and income effects by industry sector. This represents the direct incremental income associated with the Antelope Valley HSR alignment. It is the economic output generated by the employees who would not have been able to stay in the region had it not been for access granted by the high-speed rail to the Antelope Valley.

The direct impacts of the high-speed rail line are translated into total impacts using standard estimation techniques. These techniques use economic multipliers to measure the indirect and induced effects of an initial investment in the form of earnings and employment.

Due to normal constraints in the development and residential growth process, the new development will not happen immediately. This model reflects the gradual increase in development over a five year time period. This is also realistic in that the new employment made possible by the new residential development may take several years to come about as various sectors in the regional economy grow.

Table 4 and Table 5 below provide the median value for the key inputs in the analysis and the associated risk analysis ranges.

¹² Antelope Valley - Los Angeles riders are used as the constraining factor on potential household growth which is directly caused by the implementation of high speed rail. This is considered a conservative estimate, as riders to San Francisco and other points north may have also been influenced by the HSR system when making their residential location choices.

Table 4: Long Run Development Impact, Input Assumptions

	Median	Lower 10%	Upper 10%
Projected density (HH/Sq. mile)	170.38	169.25	171.49
Land area impacted (Sq. miles)	3000	2950	3050
Current area households ('000)	107.5	105	110
Intra-State transfers (%)	96	94	97
Employment per household	1.2	1.18	1.25

Source: SCAG population forecast and The Greater Antelope Valley Economic Alliance data.

Table 5: Long Run Development Impact, Output and Employment Multipliers

	Median	Lower 10%	Upper 10%
Earnings: Hotel/Lodging and Amusement Services	2.468	2.468	2.468
Earnings: Personal Services	1.796	1.796	1.796
Earnings: Business Services	1.771	1.771	1.771
Earnings: Eating and Drinking Est. Services	2.148	2.148	2.148
Earnings: Health Services	1.643	1.643	1.643
Earnings: Miscellaneous Services	2.053	2.053	2.053
Employment: Hotel/Lodging and Amusement Services	2.395	2.395	2.395
Employment: Personal Services	1.512	1.512	1.512
Employment: Business Services	1.871	1.871	1.871
Employment: Eating and Drinking Est. Services	1.504	1.504	1.504
Employment: Health Services	1.864	1.864	1.864
Employment: Miscellaneous Services	1.791	1.791	1.791

Source: US Department of Commerce, (1997), *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II)*. Bureau of Economic Analysis, Washington DC

Table 6 below shows the adjustment factors used in the simulation model to derive the impact of the Antelope Valley HSR alignment on the Gross State Product of California based upon the estimated impact on total earnings.

Table 6: Gross State Product to Employee Compensation Factors

	Median	Lower 10%	Upper 10%
Hotel/Lodging and Amusement Services	1.68	1.68	1.68
Personal Services	2.51	2.51	2.51
Business Services	1.47	1.47	1.47
Eating and Drinking Est. Services	1.60	1.60	1.60
Health Services	1.34	1.34	1.34
Miscellaneous Services	1.33	1.33	1.33

Source: US Department of Commerce, Bureau of Economic Analysis-Regional Accounts Data 1997.

3.3.2 Simulation Results

The long run total economic impacts associated with the Antelope Valley HSR alignment are estimated over a period of thirty years.¹³ The simulation results indicate that total long run impacts could reach \$3.1 billion, with an expected 38,603 additional jobs and over \$2 billion in earnings. The eighty percent confidence interval shows that the range of possible earnings is between \$1.3 billion to \$2.9 billion; the range for possible additional jobs is between 26,478 and 53,130 permanent jobs. The range for the overall long run economic impact, with an eighty percent confidence level, is between \$2.04 billion and \$4.42 billion over the thirty-year period. The investment is expected to attract about 17,267 households to the Antelope Valley region.

Tale 7 below summarizes the long-run economic impact estimates. The complete set of risk analysis results, based on the above assumptions, for employment, earnings, and the overall long run economic impacts are shown on the next pages.

¹³ The estimation of the economic impact can be viewed as conservative, the estimation used a life cycle of only 30 years which is very short for this type of projects.